

Introduction to pH

The scale of acidity is actually logarithmic similarly to the Richter scale for earthquakes and the audio scale for loudness. An exponent of 7 in 10^7 means a number that is ten times as large as 10^6 with an exponent of 6. An earthquake of magnitude 7 is actually ten times the strength of an earthquake of magnitude 6. The sound intensity of 80 dB is ten times the sound intensity of 70 dB which is in turn ten times the sound intensity of 60 dB.

Exercise: The pH scale can best be demonstrated by an actual dilution process. All the groups have a solution of 0.1 M HCl. The M means moles (the very large Avogadro's number of 6.02×10^{23}) per liter. For this acid we're talking about concentration of H^+ (actually H_3O^+). The concentration of 0.1 M can be expressed in powers of as 10^{-1} M and the pH is $-\log (10^{-1}) = 1$.

$$\text{concentration of } H^+ \text{ ions} = 0.1 \text{ M} = 10^{-1} \text{ M}$$

$$\text{logarithm of } 10^{-1} = -1$$

$$\text{pH} = - \text{logarithm of } 10^{-1} = - (-1) = 1$$

Now, make the 0.1 M solution more dilute by a factor of 10. Carefully transfer 2.5 mL of the stock solution into the 25 mL graduated cylinder. If you take too much just pour it back in to the stock container. Now add fresh water to the 25 mL mark in the graduated cylinder. The new concentration of H^+ ions is 10^{-2} M and the new pH is 2.

$$\frac{2.5}{25} \times 10^{-1} = 10^{-2}$$

$$\text{pH} = - \text{logarithm of } 10^{-2} = - (-2) = 2$$

Now, make the 0.01 M solution more dilute by a factor of 10 by diluting 2.5 mL of the pH 2 solution to 25 mL graduated cylinder. The new concentration of H^+ ions is 10^{-3} M and the new pH is 3. And do it one more time to make a pH 4 solution

Test all four solutions with pH paper.

The same demonstration can be repeated starting with a 0.1 M solution of sodium hydroxide. Basicity and acidity trend in opposite directions and quantitatively even pH and the pOH (the measure of basicity) have to add up to 14. So a 0.1 M solution of NaOH has a pOH of 1 and the pH is therefore 13.

Exercise: Conduct the dilutions of 0.1 M NaOH similarly to above for 0.1 M HCl to prepare solutions of pH 12, 11 and 10 and test with pH paper.